

LETTERS TO THE EDITOR.

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Ascent of Sap.

PROF. VINES, in his interesting address to the Botanical Section of the British Association, has referred to the problem of the ascent of sap.

We believe Prof. Vines is under a mistake when he states: "Now as to the force by which the transpiration-current is raised from the roots to the topmost leaf of a lofty tree. From the point of view that the water travels in the substance of the walls the necessary force need not be great, and would be amply provided by the transpiration of the leaves, inasmuch as the weight of the water raised would be supported by the force of imbibition of the walls. From the point of view that the water travels in the lumina, the force required to raise and support such long columns of water must be considerable." If we gather the sense aright, this statement involves perpetual motion, as may be seen by imagining both cell-walls and lumina filled with water. According to Prof. Vines, water may be obtained from the cell-walls in the higher parts of the plant with the exertion of a less force than from the lumina. If now we establish a connection, the lumina will draw from the cell-walls, and with a second connection below, an endless circulation will arise. The error arises from supposing that water can be withdrawn from the cell-walls and maintained in upward motion without opposition from the entire gravitational pull. Or, stating the matter in another way, the force which is assumed to uphold the water will also act to resist its withdrawal from the walls. Indeed the withdrawal of water from the cell-walls must be necessarily attended by much higher frictional resistance than would obtain if the supply were received from the lumina. The same objection may, in our opinion, be urged against any exposition of the "imbibition" theory. The underlying fallacy is, in fact, essentially the same as that on which the theory of capillarity and gas-pressure is founded, and which Prof. Vines rejects as "quite inadequate."

Prof. Vines, in further discussing the question, speaks of a tensile force of 360 lbs. to the square inch as being required to bring the sap to the summit of a tree 120 feet high, and states that, not only is there no evidence for the existence of such a force, but that it is even negated by the indications of the experiments of Hales and Boehm. Without discussing the validity of the supposition that such a force is anywhere required (beyond stating, as our opinion, that the grounds upon which this estimate has been obtained are very doubtful), we would certainly like to know to which of the experiments of Hales and Boehm Prof. Vines refers. So far as we are aware, the indications of Hales' and Boehm's experiments were of necessity limited by the difficulty of putting the water (external to the branches experimented upon) into a condition capable of bearing tension. These investigators, however, did not clearly understand this point. The experiments made by us in the same direction certainly all failed from this cause. The most, then, that can be admitted is that direct observation has never revealed the full state of tension of the sap of a transpiring tree, although, as in the case of some of Boehm's experiments, indications of the existence of tension were conclusively obtained. This is a very different thing from assuming that negative indications have been experimentally obtained. It is hard to see why Prof. Vines should consider the existence of a transpiration force of 20 atmospheres as improbable. It has, indeed, been shown by experiment that the turgescence of the cells of the leaves of many trees is capable of exerting a tractional force of over 20 atmospheres on the water in the conduits.

Prof. Vines dismisses the tension theory as offering no solution to the problem. But how does the matter stand? The more important points may be stated in a very few words.

In the theory of the tensile sap we find full reason for the subdivided structure of the water-conduits and for the structure of their lignified cell-walls (especially as seen in the ingenious mechanism of the bordered pit); stability is conferred on a liquid in tension and liable to the evolution of gas-bubbles by the first, and a minimum of resistance with safety against rupture is secured to the wall by the second. To raise the water through this system

the turgescence of the leaf-cells is fully adequate, even were the tension greater than what Prof. Vines demands. Again, in the light of this theory, the advantage of the periodic recurrence of root pressure becomes apparent, as a safeguard against the multiplication of functionless lumina destroying the continuity of the system. On the other hand, those who have discussed this theory have as yet brought to light no fact in vegetable physiology or anatomy opposed to its validity; while many points, e.g. the collapse of protoxylem elements, and the occurrence of year-rings, have received in it an explanation.

From the physical point of view, the theory is not only adequate to meet all the requirements of the plant, but the existence of tension in a system of minute chambers having walls at once permeable to water and impermeable to free gas, whether altogether or partially filled with dust-free water, is inevitable. The *onus* of proof does not here lie with the upholders of the tension theory merely because it has come late upon the scene, but its opponents must show how the tensile state is evaded before they can dismiss the existence of the tensile stress in the sap at such times as root-pressure is not the uplifting force.

If, then, the sap is in tension from the nature of the conditions and the leaves active in withdrawing water from above, why deny the adequacy of the explanation?

With regard to the date of publication of our theory, Prof. Vines is slightly in error. Our paper was communicated to the Royal Society in Nov. 1894, and an abstract of it appeared in NATURE in the same month.

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J. JOLY.

Homochronous Heredity and the Acquisition of Language.

THE question raised by Mr. Stuart-Menteath in NATURE of September 27 (page 524) is one of such general interest to all students of heredity that it is to be hoped that some authoritative expression of opinion will be forthcoming. Even in its present form the query involves the subject of the heredity of acquired characters, and it would be of the greatest importance to have experimental systematic observations carried out if such observations have not already been recorded. So far as my very limited acquaintance with the subject extends, I know of no such experiments. It would be desirable perhaps to widen the scope of the question, and to put it in this form: Take children of different nationalities, say German, French and English; allow them from infancy to hear all three languages indiscriminately. Is there any reason for believing that each child would show a predilection or greater facility for acquiring the language of its country?

R. MELDOLA.

October 8.

Autotomic Curves.

BRITISH mathematicians have usually employed the phrase "non-singular curve" to designate a curve which has no double points. This phrase is an exceedingly infelicitous and misleading one, since a *point of inflexion* is just as much a singularity as a *double point*.

The word *autotomic* (self-cutting) has occurred to me as a suitable one to designate a curve which has double points; but the objection to this word is that the phrase "an autotomic curve" is somewhat offensive to the ear. In the case of media which are not isotropic, mathematicians have evaded a similar difficulty, which would be caused by the use of the word *anisotropic*, by employing the term *aeolotropic*.

Perhaps some of your readers, who have kept up their classics, may be able to suggest a suitable word to convey the idea of a "not-self-intersecting-curve."

A. B. BASSET.

Fledborough Hall, Holyport, October 5.

THE OPENING OF THE MEDICAL SCHOOLS.

THE subject-matter of the studies comprising the medical curriculum lends itself exceptionally well to the delivering of inaugural addresses. Every October produces its crop of young men and women beginning the study of medicine, and to these are addressed with never-failing regularity an almost constant number of introductory lectures. To those who watch from a distance the perhaps somewhat monotonous rhythm of